WHAT IS CLAIMED IS:

1. A method to reduce mercury in gas emissions from the combustion of coal in a combustion unit, said method comprising:

a. combusting coal in a primary combustion zone of the combustion unit under conditions of low or no excess oxygen during combustion in the zone;

b. generating carbon rich fly ash during combustion;

c. releasing mercury during the combustion into flue gases generated by the combustion;

d. staging combustion air by injecting combustion air in a post-combustion zone downstream of the combustion zone in the combustion unit;

e. adsorbing the mercury in the flue gas with the fly ash, and

f. collecting the fly ash with the adsorbed mercury in a combustion waste treatment system.

2. A method as in claim 1 wherein a level of excess oxygen during combustion is less than about 1.0%.

3. A method as in claim 1 wherein a level of excess oxygen during combustion is less than about 0.5%.

4. A method as in claim 1 wherein a level of excess oxygen during combustion is less than a

stoichiometric amount of oxygen needed for the combustion of the coal.

5. A method as in claim 1 further comprising cooling the fly ash with the active carbon to a temperature below 450 degrees Fahrenheit to facilitate the adsorption of the mercury.

6. A method as in claim 1 wherein the post-combustion zone includes an overfire burnout zone into which is injected the staged combustion air.

7. A method as in claim 1 wherein the mercury released from combustion is mostly elemental mercury (Hg^0) and further comprising oxidizing the elemental mercury as the flue gases cools.

8. A method as in claim 7 wherein the oxidized mercury is removed from flue gas in a scrubber.

9. A method as in claim 1 wherein the combustion waste treatment system includes a particle control device which captures the fly ash with adsorbed mercury and discharges the captured fly ash to a fly ash collection unit.

10. A method as in claim 1 wherein the combustion waste treatment system includes a particle control device which captures the fly ash after the fly ash cools to a temperature no greater than about 400 degrees Fahrenheit.

11. A method as in claim 1 wherein a loss on ignition level of the fly ash is at least 0.5 percent.

12. A method as in claim 1 wherein a stoichiometric ratio (SR_1) of the combustion of coal in a primary combustion zone of the combustion system is in a range of about 0.5 to about 1.1.

13. A method as in claim 1 wherein a stoichiometric ratio (SR_1) of the combustion of coal in a primary combustion zone of the combustion system is in a range of about 0.8 to about 1.05.

14. A method as in claim 1 further comprising injecting activated carbon downstream of the post-combustion zone and upstream of the collection of fly ash.

15. A method as in claim 1 further comprising injecting coal into a reburn zone in the post-combustion zone and upstream of an overfire air burnout zone.

16. A method as in claim 14 wherein an amount of reburning fuel is in a range of about 10 to about 30 percent of a total heat input of fuel used for the combustion of coal.

17. A method as in claim 14 wherein an amount of reburning fuel is in a range of about 15 to about 25 percent of a total heat input of fuel used for the combustion of coal.

18. A method as in claim 1 wherein combustion occurs in a low nitrogen oxide (NOx) burner.

19. A method to reduce mercury in gas emissions from the combustion of coal in a combustion system, said method comprising:

a. combusting the coal in a primary combustion zone of the combustion system, wherein elemental mercury (Hg^0) is released in the flue gas produced by the combustion;

b. staging combustion air supplied to the combustion system by adding a portion of the combustion air to the primary combustion zone and a second portion of the combustion air to an overfire air zone downstream of the combustion zone;

c. maintaining a level of excess oxygen in the primary combustion zone of no greater than 1.0 percent so as to release active carbon in the fly ash generated by the combustion of coal;

d. oxidizing the elemental mercury by generating oxidized mercury (Hg^{+2});

e. adsorbing the elemental mercury in the flue gas by the active carbon in the fly ash, and

f. collecting the fly ash with adsorbed mercury in a combustion waste treatment system.

20. A method as in claim 18 wherein a level of excess oxygen during combustion is less than a stoichiometric amount of oxygen needed for the combustion of coal.

21. A method as in claim 18 further comprising cooling the fly ash with the active carbon to a temperature below 450 degrees Fahrenheit to facilitate the adsorption of the mercury.

22. A method as in claim 18 further comprising cooling the fly ash with the active carbon to a temperature no greater than 350 degrees Fahrenheit to facilitate the adsorption of the mercury.

23. A method as in claim 18 wherein the combustion waste treatment system includes a particle control device which captures the fly ash with adsorbed mercury and discharges the captured fly ash to a fly ash collection unit.

24. A method as in claim 18 wherein the combustion waste treatment system includes a particle control device which captures the fly ash after the fly ash cools to a temperature no greater than 400 degrees Fahrenheit.

25. A method as in claim 18 wherein a loss on ignition level of the fly ash is at least 0.5 percent.

26. A method as in claim 18 further comprising applying air staging by overfire air injection to generate excessive active carbon in the fly ash.

27. A method as in claim 18 wherein a stoichiometric ratio (SR_1) of the combustion of coal in a primary combustion zone of the combustion system is in a range of about 0.5 to about 1.1.

28. A method as in claim 18 wherein a stoichiometric ratio (SR_1) of the combustion of coal in a primary combustion zone of the combustion system is in a range of about 0.8 to about 1.05.

29. A method as in claim 18 further comprising coal reburning in the combustion system to generate carbon in fly ash generated during combustion.

30. A method as in claim 28 wherein an amount of reburning fuel is in a range of about 10 to about 30 percent of a total heat input of fuel used for the combustion of coal.

31. A method as in claim 28 wherein an amount of reburning fuel is in a range of about 15 to about 25 percent of a total heat input of fuel used for the combustion of coal.

32. A method as in claim 18 wherein combustion occurs in a low nitrogen oxide (NOx) burner.

33. A system to treat mercury in flue gas emissions from a coal fired furnace comprising:

a) a primary combustion zone receiving combustion air and having a downstream passage for flue gases and fly ash generated during combustion;

b) a coal injector adapted to inject coal into the primary combustion zone;

c) an air injector adapted to introduce combustion oxygen into the combustion zone, wherein an amount of excess oxygen in the zone is no greater than 1.0 percent so as to release active carbon in the fly ash generated by the combustion of coal;

an overfire air burnout zone downstream of the combustion zone and included in the downstream passage, wherein combustion air is injected into the burnout zone;

a combustion treatment waste system coupled to the flue gas output and a discharge for captured particulate waste, and

wherein said primary combustion zone burns the coal such that the fly ash has active carbon to adsorb the mercury released in the flue gas.

34. A system as in claim 32 further comprising a duct downstream of the primary combustion zone to cool the flue gas to collect fly ash with the absorbed mercury.

35. A method to reduce mercury in gas emissions from the combustion of coal in a combustion unit, said method comprising:

a. combusting coal in a combustion zone of the combustion unit under conditions of low or no excess oxygen during combustion in the zone;

b. generating carbon rich fly ash during combustion;

c. releasing mercury during the combustion into flue gases generated by the combustion;

d. adsorbing the mercury in the flue gas with the fly ash, and

e. collecting the fly ash with the adsorbed mercury in a combustion waste treatment system.

36. A method as in claim 35 wherein a level of excess oxygen in flue gas is less than 2.0%.

37. A method as in claim 35 wherein a level of excess oxygen in flue gas is less than 1.0%.

38. A method as in claim 35 wherein oxidized mercury is removed in a scrubber.